
Short-Term Oxidation Behavior and Mechanism of Nickel-Based Superalloy CMSX-4 at 1100°C

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Abstract Nickel-based superalloys undergo oxidation in high-temperature corrosive environments, but the oxidation behavior and mechanism during the early stages remain unclear. The study investigated the oxidation behavior of nickel-based superalloy CMSX-4 of short-term oxidation in air at 1100°C, employing multi-scale characterization techniques. The results indicate that the oxidation of the CMSX-4 alloy adheres to parabolic kinetics, ultimately forming a complex four-layer oxide scale comprising a NiO(CoO) layer, CoCr₂O₄ and TiTaO₄ layer, NiAl₂O₄ layer, and Al₂O₃ layer. CoCr₂O₄ is formed by the reaction of CoO and Cr₂O₃, while TiTaO₄ is transformed from TiO₂ and Ta₂O₅. Furthermore, NiO reacts with Al₂O₃ to generate NiAl₂O₄. The excellent oxidation resistance is primarily attributed to the formation of dense Al₂O₃ layer. It acts as the primary protective barrier for the alloy matrix, impeding element diffusion and preventing further oxidation.

Keywords Nickel-based superalloys, High-temperature oxidation, Mechanism, High-resolution characterization